ISSN 1324-5910

All correspondence to:

Associate Professor Andrew C. Worthington
Editor, *Discussion Papers in Economic, Finance and International*
School of Economics and Finance
Queensland University of Technology
GPO Box 2434, BRISBANE QLD 4001, Australia

Telephone: 61 (0)7 3864 2658
Facsimilie: 61 (0) 7 3864 1500
Email: a.worthington@qut.edu.au

Queensland University of Technology

DISCUSSION PAPERS IN ECONOMICS, FINANCE AND INTERNATIONAL COMPETITIVENESS

Demand for M2 in Developing Countries: An Empirical Panel Investigation

Abbas Valadkhani
and
Mohammad Alauddin

Discussion Paper No. 149, July 2003

Series edited by
Associate Professor Andrew Worthington

School of Economics and Finance

DEMAND FOR M2 IN DEVELOPING COUNTRIES: AN EMPIRICAL PANEL INVESTIGATION

ABBAS VALADKHAN*I

and

MOHAMMAD ALAUDDIN**

ABSTRACT *A significant body of literature on developed countries support the view that disequilibrium in the money market can affect the future output gap and/or inflation. This paper examines the major determinants of the demand for real money balances in eight developing countries for which consistent annual time series data are available. Pooling cross-country and time series data for the 1979-1999 period and employing the seemingly unrelated regression (SUR) estimation technique, this paper models a standard money demand function. Various country-specific coefficients are allowed to capture inter-country heterogeneities. Consistent with theoretical postulates, this paper finds that the demand for money positively responds to an increase in real income and negatively to a rise in the interest rate spread, the rate of inflation and the US long-term interest rate. This study supports the hypothesis that disequilibrium in the money market can exacerbate inflation and widen the output gap.*

JEL classification numbers: E41, E52, and C33, O11

Keywords: Demand for Money, Money and Interest Rate Spread, Panel Data, Macroeconomic Analyses of Economic Development.

1. Introduction

The importance of a well-specified demand for money to the implementation of monetary policy is well recognised in the existing literature. Goldfeld (1994) considers that the relation between the demand for money and its main determinants is an important building block in macroeconomic theories and is a crucial component in the

* Corresponding Author's Address: Dr Abbas Valadkhani, School of Economics and Finance. Queensland University of Technology, Gardens Point Campus, GPO Box 2434 Qld 4001, Brisbane-Australia, Email: a.valadkhani@qut.edu.au, Tel: +61-7-3864 2947, Fax: +61-7-3864 1500

** MOHAMMAD ALAUDDIN, School of Economics, The University of Queensland, Brisbane Qld 4072, Email: m.alauddin@economics.uq.edu.au

conduct of monetary policy. As a result, the demand for money is one of the topical issues that has attracted the most attention in the literature both on developed and developing countries. In the context of developed countries it is argued that disequilibrium in the demand for money (defined as the difference between the real money stock and the long-term equilibrium real money stock) may affect the efficacy of interest rate policy in the long run via its impact on output gap and/or inflation. There are a number of studies that highlight the importance of the demand for money in developed countries because the "real money gap" (the resulting residuals from the money demand function) helps to forecast future changes in the output gap and/or inflation (see, *inter alia*, Laidler, 1999, Gerlach and Svensson, 2002, and Siklos and Barton, 2001).

A consensus among economists is emerging in support of the view that it is not a valid argument to focus exclusively on a single policy instrument and entirely neglect an important information variable because both the interest rate and monetary aggregates do matter in policy formation. Given that the output gap is deemed to be an important factor in determining the official interest rate (as supported by the Taylor rule), then one can conclude that the real money gap indirectly affects the interest rate via its direct influence over the output gap and/or inflation. Therefore, a well-functioning and stable money demand function is still important in this era of inflation targeting. It is essential to track both the interest rates and the money stock in order to assess precisely how monetary policy impacts upon the economy. Laidler (1999, p.26) in the context of the OECD countries, which pursue inflation-targeting policy, posits that monetary aggregates should not be used "as the only target of monetary policy, but rather as a supplementary intermediate target variable in a regime whose principal anchor is an inflation goal".

This paper contributes to the vast literature on the demand for money in two ways. First, it examines the impact of the interest rate spread on the demand for money in developing countries, an important issue which has not been investigated by previous studies. Existing studies considered only one interest rate in the money demand equation. But this single interest rate does not adequately represent the opportunity cost of holding money, particularly in an era of financial deregulation and innovation. Second, for the first time this paper provides some new empirical evidence supporting the view that disequilibrium in the money market can exacerbate inflation and widen the output gap in developing countries, an important issue which has received considerable attention in developed countries (*e.g.* McCallum, 2001) but not in the context of developing countries.

The rest of this paper is structured as follows. Section 2 provides a brief review of the relevant literature. Section 3 postulates a theoretical model that captures a conventional dynamic model of the demand for money using data for eight developing countries from 1979 to 1999. These countries are Malaysia, Chile, Thailand, Papua New Guinea, Bangladesh, Sri Lanka, Sierra Leone, and the Philippines. Definitions of the variables, sources of the data employed as well as the relevant descriptive statistics are presented in Section 4. The empirical econometric results for the demand for money function, as well as policy implications of the study are set out in Section 5. The seemingly unrelated regression (SUR) estimation technique is used to estimate a standard money demand function with various country specific coefficients (such as the fixed effects estimator) which capture heterogeneity among these countries. Section 6 presents the conclusion.

2. A Brief Review of Literature

A considerable body of literature has investigated the demand for money in developing countries (Wong, 1977, Arize 1989, Gupta and Moazzami, 1989, Arrau, 1991, Bahmani-Oskooee and Malixi, 1991, Agenor and Khan, 1992, Simmons, 1992, Deutsch and Zilberfarb, 1994, and Sriram, 2000). For example, Arize (1989) estimates the demand for money in four Asian economies: Pakistan, the Philippines, South Korea, and Thailand. He argues that foreign interest rates, exchange rate depreciation and technological change are important determinants of the Asian money demand functions. Bahmani-Oskooee and Malixi (1991) estimate the demand for money function in 13 developing countries as a function of inflation, real income and the real effective exchange rate . They conclude that, *ceteris paribus*, a depreciation in real effective exchange rate results in a fall in the demand for domestic currency. However, they did not include the interest rate spread to capture the general process of financial asset substitution.

Agenor and Khan (1992, 1996) estimate a dynamic currency substitution model incorporating forward-looking rational expectations for a group of ten developing countries. They also allude to the view that the foreign rate of interest and the expected rate of depreciation of the parallel market exchange rate play a crucial role in the choice between holding domestic money or switching to foreign currency deposit held abroad. Simmons (1992) employs an error-correction model to estimate the demand for money in five African economies. This study emphasises the role of opportunity cost variables including the domestic interest rate and expected exchange-rate depreciation. His empirical results indicate that the domestic interest rate is an important determinant of the demand for money functions for three of the five countries, whereas external opportunity cost variables are significant for only one of the others. He also finds that in four out of five cases inflation plays an extremely important role in determining the demand for money. Due to the lack of consistent and reliable data on the parallel exchange rate and real effective exchange rate, the present study assumes that the impact of a depreciating currency is also captured by the inflation rate[1]. The review of literature on the demand for money, therefore, reveals a growing consensus among economists that M2 should be considered as an appropriate indicator of monetary aggregate.

The demand for money in the literature (*e.g.* Ericsson, 1998, Beyer, 1998, Coenen and Vega 2001, and Felmingham and Zhang, 2001) is conventionally specified as a function of real income, a long-run interest rate on substitutable non-money financial assets, a short-run rate of interest on money itself, and the inflation rate. As mentioned earlier in this section, the problem with this specification is that it does not include a measure of exchange rate and a foreign interest rate both of which can capture the general process of financial asset substitution. Mundell (1963, p.484) conjectured that in addition to the interest rates and the level of real income, the demand for money should be augmented by the exchange rate. Ewing and Payne (1999) have investigated the role of the exchange rate on the demand for narrow money in several developed countries. They utilise a standard cointegration technique to examine the relevance of the inclusion of the effective exchange rate in the money demand function. They suggest that "income and interest rate are sufficient for the formulation of a long-run stable demand for money in Australia, Austria, Finland, Italy, U.K., and U.S. However, for Canada, Germany, and Switzerland, the effective exchange rate should be incorporated" (Ewing and Payne, 1999, p.84).

A number of studies have considered the general process of financial asset substitution and justified the use of an exchange rate and a foreign interest rate in the analysis of demand for money. These include, *inter alia*, Bahmani-Oskooee and Rhee (1994), Traa (1991) and Chowdhury (1995). All these studies are clearly in favour of both the currency substitution and capital mobility hypotheses. Therefore, it is very important to include the real effective exchange rate and a measure of the long-term foreign interest rate (*e.g.* the long-run US Treasury bond yield) in the money demand function. However, as mentioned earlier due to the lack of consistent and reliable data on the parallel exchange rate and real effective exchange rate, in this study the impact of a depreciating currency is assumed to be captured by the inflation rate.

3. Theoretical Framework

Against the background of the preceding discussion, the present paper postulates the demand for money as a function of the inflation rate, the long- and short-run interest rates, the US long-run interest rate, real income and the lagged value of real money balances. Formally the equation is specified as follows:

$$(m_i - p_i)_t = \gamma_0 + \gamma_1 \Delta p_{it} + \gamma_2 RL_{it} + \gamma_3 RS_{it} + \gamma_4 R_{USt} + \gamma_5 y_{it} + \gamma_6 (m_i - p_i)_{t-1} + \varepsilon_{it} \qquad (1)$$

where i denotes a specific country varying from 1 to 8, t is time starting from 1979 to 1999, m is nominal money demanded, p is the price level, y is the real GDP-production as a proxy to capture transactions and precautionary demand for money, RL is the long-run rate of return on assets outside of money, RS is the short-run rate of interest on money itself, R_{US} is the long-run US Treasury bond yield. All variables shown in lowercase (*i.e.* m, y, and p) are in natural logarithms while the remaining variables (*i.e.* RL, RS and R_{US}) are in levels. As a result, γ_1 and γ_5 denote the short-run income and inflation elasticities of the demand for money, whereas γ_2 to γ_4 are short-run semi-elasticities of RL, RS and R_{US} with respect to money demand, respectively. Adopting an adaptive expectations model, one can divide these coefficients by $(1-\gamma_6)$ to obtain the corresponding long-run elasticities or semi-elasticities. It should be noted that due to the use of only 20 observations in the estimation process (for each country) the error correction model has not been employed.

The rate of inflation, or $\Delta p_t = ln(P_t) - ln(P_{t-1})$, is considered as a proxy to measure the return on holdings of goods (including foreign currencies), and its coefficient should be negative, *i.e.* $\gamma_1 < 0$, as goods (*e.g* real estate and other currencies) are an alternative to holding domestic currency. According to Ericsson (1998, 309), the exclusion or inclusion of inflation in this equation is a matter of empirical investigation. It is also expected that *RL* (the lending interest rate) has a negative sign (or $\gamma_2 < 0$), whereas the coefficient for the short-run rate of interest (the deposit interest rate or RS) is positively (or $\gamma_3 > 0$) correlated with money demand. Following Agenor and Khan (1992, 1996) and Arize, Malindretos and Shwiff (1999) the standard demand for money function is further augmented by the US real long-run interest rate (R_{US}). The expected sign for this variable is likely to be negative (or $\gamma_4 < 0$), *ceteris paribus*, supporting the currency substitution and capital mobility hypotheses. This basically means that a rise in the real interest rate in the US is likely to result in a higher propensity to substitute away from domestic currency.

The expected sign and magnitude of the coefficient for *y* is as follows: if $\gamma_5 = 1$, the quantity theory applies; if $\gamma_5 = 0.5$, the Baumol-Tobin inventory-theoretic approach is applicable; and if $\gamma_5 > 1$, money can be considered a luxury. According to Ball (2001), an income elasticity of less than unity has a number of implications for monetary policy. For instance, one may conclude that the Friedman rule is not optimal in this case and the supply of money should grow more sluggishly than output to achieve the goal of price stability (Ball, 2001, p.36)[2].

In order to capture inter-country heterogeneities one can use the fixed effect estimator, which allows γ_0 to vary across countries by estimating different intercept terms. This method is also referred to as the "least squares with dummy variables" or LSDV. In this method we subtract the "within" mean from each variable and then estimate OLS using the transformed data. However, one can argue that these considerable differences may not be adequately captured by a simple "intercept varying model". Given the importance of the income elasticity of the demand for money and the varying dynamic adjustment processes across these countries, the model allows γ_0, γ_5 and γ_6 to differ in the estimation process. Equation (1) is thus recast as follows:

$$(m_i - p_i)_t = \gamma_{i0} + \gamma_1 \Delta p_{it} + \gamma_2 RL_{it} + \gamma_3 RS_{it} + \gamma_4 R_{USt} + \gamma_{i5} y_{it} + \gamma_{i6}(m_i - p_i)_{t-1} + e_{it} \tag{2}$$

Allowing γ_{i0}, γ_{i5} and γ_{i6} to take specific values for each country entails a loss of additional 21 (24-3) degrees of freedom. Estimating county-specific coefficients involves a trade-off between the degrees of freedom lost and the resulting gain obtained in terms of country specificity and the enhanced goodness-of fit statistics. However, it is necessary to formally test the following three hypotheses before accepting the estimated equation (2) in lieu of equation (1).

$$H_0^1 : \gamma_{i0} = \gamma_0$$
$$H_0^2 : \gamma_{i5} = \gamma_5$$
$$H_0^3 : \gamma_{i6} = \gamma_6$$

If we reject these three null hypotheses, the use of equation (2) will be justified (the gains in identifying country-specificity outweighing the losses). Furthermore, if in practice γ_2 and γ_3 are equal in magnitude but opposite in sign, equation (2) can be rewritten in the following form:

$$(m_i - p_i)_t = \gamma_{i0} + \gamma_1 \Delta p_{it} + \gamma_2 (RL_i - RS_i)_t + \gamma_4 R_{USt} + \gamma_{i5} y_{it} + \gamma_{i6}(m_i - p_i)_{t-1} + e_{it} \tag{3}$$

where *RL-RS* is the interest rate spread. The Parks or the seemingly unrelated regression (SUR) technique (or Zellner's method) is employed to estimate equations 2 or 3. In order to address simultaneity problem among variables in equation (3), the SUR weighted least squares which is the feasible GLS estimator is used in the estimation process. This method also accounts for heteroskedasticity and contemporaneous correlation in the errors across equations[3]. This estimation method requires that the number of time series observations (*t*) must be greater than the number of countries (*i*) (See EViews, 2002). Given that the sample of countries equal eight (i=1, 2,…, 8) and the time period under investigation spans from 1979-1999, this does not pose any problem.

4. The Data

Table 1 presents descriptions of the data employed as well as the relevant summary statistics. Annual time series data for the period 1979-1999 are as follows: Nominal $M2_i$ (1995=100); the consumer price index or P_i (1995=100); RS_i denotes the deposit interest rate as a proxy for the short-run interest rate (fraction); RL_i is the lending interest rate as a proxy for the long-run interest rate (fraction), Y_i *is* real GDP (1995=100), R_{US} is the US long-term interest rate (fraction). More specifically according to the World Bank (2001): deposit interest rate is the rate paid by commercial or similar banks on demand, time, or savings deposits; lending interest rate is the rate charged by banks on loans to prime customers, the interest rate spread is the interest rate charged by banks on loans to prime customers minus the interest rate paid by commercial or similar banks for demand, time, or savings deposits; and finally real interest rate is the lending interest rate adjusted for inflation as measured by the GDP deflator. As indicated earlier, all variables shown in lowercase (*i.e.* m, y, and p) are in natural logarithms and the remaining variables (*i.e.* RL, RS and R_{US}) are in levels.

[Table 1 about here]

According to de Brouwer, Ng and Subbaraman (1993, p.10), a broader measure of money is more appropriate for modelling purposes because it: a) is less distorted by financial deregulation and innovations; and b) has a more reliable relationship with income. M2 is the broadest monetary aggregate for which data are available for all the eight countries for the period under consideration. It should be noted that the choice of interest rates depends on the measure of money being modelled. Ericsson (1998) suggests that long-run rates should not be included in the demand equation for M1. However, if a broader definition of money (such as M2) is modelled, it is essential to incorporate longer-term interest rates in the demand for money function so as to capture financial asset substitutions. Since this paper examines the demand for M2, *RL* is best proxied by a "long-run rate" such as the lending interest rate, which has a longer maturity than *RS*. It is argued that the use of broader monetary aggregates necessitates the inclusion of a long-term interest rate in the money demand equation.

The choice of the countries in this paper was contingent upon the availability of consistent time series data on all the variables included in the model, particularly the interest rate spread which is the most limiting constraint. While the number of countries in the sample is only eight, they differ considerably among themselves in terms of per capita income, human development, degree of industrialisation and other indicators of socio-economic development. Allowing for country-specific coefficients in equations (2) and (3), to some extent, helps capture the cross-country diversity.

5. Empirical Results and Policy Implications

Equation (3) is estimated by the SUR technique and pooling annual data from 1979 to 1999 for Malaysia, Chile, Thailand, Papua New Guinea, Bangladesh, Sri Lanka, Sierra Leone, and the Philippines. The econometric results are presented in Table 2. A convergence value of 0.02 is chosen in the estimation process, which involves 24 iterations. Before proceeding any further one needs to test the three null hypotheses discussed in Section 3 (*i.e.* H_0^1, H_0^2 and H_0^3). These results are presented in Table 3. All of the three null hypotheses are rejected at 1 per cent level, justifying the use of country-specific coefficients for intercept, the income elasticity and the lagged dependent variable. In other words, these results indicate that equations (2) or (3) must be used instead of equation (1). At this stage it is also important to test if $\gamma_2 = -\gamma_3$ because if the null is rejected, the use of the interest rate spread (RL_i-RS_i) in equation (3) could result in biased estimates. Given that F(1,132)=0.79 [probability=0.38] and $\chi^2(1)=0.79$ [probability=0.37], the null hypothesis of $\gamma_2= - \gamma_3$ cannot be rejected at the 5 per cent significance level. Thus one can conclude that the own and outside rates of return may result in coefficients of equal magnitude but opposite sign.

[Tables 2 and 3 about here]

The estimated coefficients of equation (3) presented in Table 2 are consistent with *a priori* expectations regarding sign and order of magnitude and are statistically highly significant. This equation also performs very well in terms of goodness-of-fit (adjusted $R^2 = 0.987$) and it generates white noise residuals.

According to Arrau (1991) one problem associated with the analysis of the money demand equation in the context of developing countries is the existence of highly autocorrelated residuals. This problem can create economic and econometric complications in deriving any inference from the empirical model and can be the source of faulty policy advice. In order to test this "econometric pathology", it is necessary to test for serial autocorrelation of the resulting residuals for each country (e_{it}). A lag length of 2 is chosen in the computation of the autocorrelation (AC) and partial autocorrelation (PAC) of e_{it}, as autocorrelation is highly likely to be of up to order 2 in annual data. The computed AC and PAC as well as the Ljung-Box *Q*-statistics and the corresponding *p*-values are reported in Table 4. The *Q*-statistic is used to test the null hypothesis that the resulting residuals from the estimated equation (3) for each country are free of autocorrelation. The results of this test reported Table 4 clearly show that at the 5 per cent level there is no evidence of autocorrelation (first or second order) in the residuals.

[Table 4 about here]

Furthermore, in order to test normality of the residuals, the Jarque-Bera statistic and the corresponding *p*-values are presented in Table 5. If the country-specific residuals (e_{it}) are normally distributed, the Jarque-Bera statistic should not be significant. As can be seen from Table 5, these results indicate that the normality assumption is not rejected. Given that only 20 annual observations (1980-1999) are used in the estimation process (after considering the lagged dependent variable), the results reported in Tables 4 and 5 need to be treated with caution because all these test statistics are appropriate for large samples. Overall, it can be argued that the estimated equation (3) presented in Table 2 performs very well in terms of goodness-of-fit statistics and it also passes the reported diagnostic tests.

[Table 5 about here]

According to the results set out in Table 2 and consistent with theoretical postulates discussed in Section 3, the demand for broad money is positively related to real income (y) and negatively to both the interest rate spread $(RL_i\text{-}RS_i)$ and, the US real interest rate and the rate of inflation. It should be noted that the estimated country-specific coefficients for $(m_i/p_i)_{t-1}$ in Table 2 are well below unity, with the only exception being Sierra Leone (0.927), where the speed of adjustment is quite low.

The long-run income elasticity [measured by $\gamma_{i2}/(1-\gamma_{i6})$] are greater than unity for Sierra Leone, the Philippines, Thailand, Malaysia and Bangladesh, and less than one for Chile, Papua New Guinea and Sri Lanka. Therefore, it seems that the quantity theory of money, supporting a long-run income elasticity of unity, does not apply in the context of these eight countries.

Based on the results presented in Table 2 one can argue that the inflation rate (as the opportunity cost of the monetary asset relative to real assets or other excluded financial assets *e.g.* such foreign currencies) is negative (γ_1 = –0.63) and highly significant, suggesting that the demand for money has also implications for portfolio decisions in these countries. In other words, inflation has a short-term effect (with an inflation elasticity of -0.63) on real money balances, whereby an increase in the rate inflation immediately encourages agents to diversify their portfolios by acquiring real assets amongst other things.

Given that the estimated coefficients of γ_3 = –0.30 and γ_4 = –0.58 are the semi-elasticities for the interest rate spread and the US long-run interest rate respectively, one can convert them to elasticities by multiplying each one of them by the value of its corresponding variable in each year. Thus the magnitudes of the resulting elasticities vary depending on the value taken by these variables. According to Table 2, the demand for real money balances is negatively related to both the interest rate spread (defined as RL_i-RS_i) and the US long-run real interest rate. Therefore, *ceteris paribus*, a rise in both the US real interest rate and the domestic interest rate spread can lead to a significant decrease in the demand for real money balances. Under these circumstances individuals either diversify their portfolios in the economy by substituting other currencies (say $US) for domestic currency in their financial portfolio or acquire other financial and/or real assets (say shares, gold and real estate property).

Attention is now directed to the relationship between the lagged disequilibrium in the money market and the output gap and inflation. The lagged disequilibrium in the money market can be regarded as a useful information variable and is proxied by the resulting residuals (e_{it-1}) reported in Table 2. The output gap for each country is measured by the difference between real actual GDP and the real potential GDP or (y_{it}-y^{p}_{it}). The potential output is calculated by employing the Hodrick and Prescott (HP) filter (Hodrick and Prescott, 1997) that is widely used in the literature (de Brouwer, 1998 and Haltmaier, 2001) to decompose a time series into trend and cyclical components as well as the computation of potential output (y^{p}). The two-sided linear HP method estimates the potential output (y^{P}) from actual output y by minimizing the variance of y around y^{p}. More specifically, the HP filter sets the potential component of output in order to minimise the following loss function:

$$L = \sum_{t=1}^{T} (y_t - y_t^p)^2 + \lambda \sum_{t=2}^{T-1} \left[(y_{t+1}^p + y_t^p) - (y_t^p - y_{t-1}^p) \right]^2 \qquad (4)$$

where λ is the smoothing weight on potential output growth and T is the sample size.

Because of the use of annual time series data in this paper, we have followed de Brouwer (1998) and assumed that λ=100. In an iterative process the HP filter sets the potential component of output or y^{p} to minimise the loss function or L as shown in equation (4). It should be noted that as λ approaches zero, potential output would converge to actual output. Therefore, a lower smoothing factor (λ) generates a 'smaller' estimate of the gap and vice versa. One advantage of the HP filter is that it makes the output gap stationary using a wide range of smoothing values (Hodrick and

Prescott 1997) and it also allows the trend to vary through time. However, Brouwer (1998, p.7) points out that the HP filter also has “the distinct disadvantage that the selection of the smoothing weight is arbitrary, and that this matters to the estimate.” The authors are quite aware of the limitations of the use of HP filter in the computation of the output gap. But there are two other alternatives: a linear trend approach and the production function method. While the “trend method” is not necessarily superior to the HP filter approach, the production function method requires data on capital stock (K) and labour (L) both of which are either unavailable or of poor quality, especially in the context of developing countries. Therefore, we have little choice but to use the HP filter approach while acknowledging its limitations.

After calculating the output gap for each country, we have estimated two equations which are presented in Table 6. The first equation specifies the output gap as a function of the lagged disequilibrium in the money market (or e_{it-1}) while the second one captures the relationship between inflation (as the dependent variable) and e_{it-1}. The results indicate that the country-specific intercepts are not significant in the output gap equation but they are highly significant in the inflation equation (the test results are not reported here but are available from the authors upon request). It should be noted that inflation varies substantially across countries investigated in this paper. As can be seen from Table 1, the average annual inflation rate during the period 1979-1999 varies from a minimum of 3.7 per cent in Malaysia to 39.5 per cent in Sierra Leone. Due to these considerable differences, the fixed effects model (country-specific intercepts) is allowed to capture these differences for the inflation equation presented in Table 6. Figure 1 shows the estimated country-specific intercepts and the corresponding average (actual) annual rates of inflation for these eight countries. As can be seen, those countries, which experience higher rates of inflation, are exactly those with the higher estimated fixed effects (intercepts).

[Figure 1 and Table 6 about here]

The positive and highly significant coefficients on e_{it-1} in these two equations set out in Table 6) clearly suggest that an increase in the lagged disequilibrium in the money market (*i.e.* excess of money supply over money demand as captured by equation 3) can bring about higher inflationary pressure and enlarge the output gap. It should be noted that the impact of this disequilibrium on inflation (+0.16) is more pronounced than that of the output gap (+0.067). These results are broadly consistent with those of previous studies in the context of developed countries (see, *inter alia*, Laidler, 1999, Gerlach and Svensson, 2002, and Siklos and Barton, 2001).

6. Conclusion

The existence of a well-specified demand for money is very important for the conduct of monetary policy, whether the central banks' major policy variable is the stock of money or the official interest rate or inflation. There is growing evidence in the literature that disequilibrium in the money market can affect the future output gap and/or inflation. This paper examines the major determinants of the demand for real money balances in eight lower- and middle income countries (as defined by the World Bank) for which consistent annual time series data are available, namely Malaysia, Chile, Thailand, Papua New Guinea, Bangladesh, Sri Lanka, Sierra Leone, and the Philippines. Pooling the time series data for the period 1979-1999 and cross-sectional data for these eight countries, the seemingly unrelated regression (SUR) estimation technique is used to model a standard money demand function. Various country specific coefficients (such as the fixed effects estimator) are allowed to capture heterogeneity among these countries.

Consistent with theoretical postulates, this paper finds that the demand for money positively responds to an increase in real income and negatively to a rise in the interest rate spread, the rate of inflation and the US long-term interest rate, indicating that the demand for M2 is a predictable monetary aggregate. This paper also provides some new empirical evidence that the lagged disequilibrium in the money market can lead to higher inflation and wider output gap. The estimated model in this paper can provide useful policy guidelines to the developing countries' central banks in their quest for price stability and narrowing the divergence between potential output and actual output. It is argued that any persistent disequilibrium in the money market (*e.g.* excess money supply) can bring about rising future prices and widening gap between actual and potential output. According to Woodford (2001, p236) the stabilization of both inflation and the output gap is an appropriate goal, particularly when the output gap is properly defined. Thus, if the objectives of these countries are to minimise the output gap and price instability, they should avoid creating unnecessary disequilibrium in the money market. That is why Gerlach and Svensson (2001, p.24) posit that "it is appropriate to consider both the real money gap and output gap when judging price pressures". Therefore, it can be concluded that the demand for money is a useful policy tools because the "real money gap" helps to forecast future changes in the output gap and/or inflation even in developing countries.

On the whole, this paper seems to have broken new grounds in two ways. First, in contrast to the existing literature, the role of interest rate spread as an independent variable in the money demand equation is assessed. Secondly, for the first time, the extent to which disequilibrium in the money market can exacerbate inflation and widen the output gap has been examined in a cross-country context for the developing world. However, the findings of this study, while substantial and revealing, need to be judged in the light of two *caveats*. First, the quality of secondary data from developing countries needs to be borne in mind. Second, the data relate to a small number of countries and this makes generalisations somewhat difficult. Nevertheless, the findings are indicative of the forces at work.

Table 1. Summary statistics and description of the data employed: eight developing countries, 1979(80)-1999

Variable/country	Mean	Maximum	Minimum	Std. Dev.
Real money balances $M2_i/P_i$ 1995=100				
Malaysia	63.7	146.2	20.9	40.5
Chile	72.2	141.3	28.1	32.8
Thailand	58.7	125.1	14.4	38.8
Papua New Guinea	89.1	121.3	65.4	16.5
Bangladesh	69.3	124.1	29.1	30.4
Sri Lanka	72.6	106.4	47.0	18.8
Sierra Leone	222.6	460.0	100.0	122.4
Philippines	67.3	142.7	32.0	35.8
Growth of real money balances % $\Delta(m_i/p_i)$				
Malaysia	9.7	20.1	-6.6	6.1
Chile	8.1	20.4	-4.7	6.4
Thailand	10.8	18.1	1.5	5.5
Papua New Guinea	1.1	15.8	-14.7	7.7
Bangladesh	7.3	24.7	-0.6	6.2
Sri Lanka	4.1	12.3	-4.8	5.2
Sierra Leone	-6.4	24.7	-53.1	18.8
Philippines	7.5	37.1	-22.3	12.1
Nominal $M2_i$ (1995=100)				
Malaysia	59.4	168.1	11.5	49.0
Chile	52.3	174.9	1.7	55.0
Thailand	55.1	151.6	6.2	48.1
Papua New Guinea	71.0	157.5	29.2	41.5
Bangladesh	58.5	156.3	7.6	45.0
Sri Lanka	54.4	154.8	7.2	46.3
Sierra Leone	60.1	292.5	0.3	83.1
Philippines	55.5	192.8	4.9	57.9
Growth of nominal Money and quasi money $\Delta lnM2_i$ %				
Malaysia	13.4	23.6	-1.5	6.6
Chile	23.1	48.2	9.2	9.0
Thailand	16.0	23.7	5.2	4.9
Papua New Guinea	8.3	26.8	-3.3	7.4
Bangladesh	15.1	33.6	9.3	6.5
Sri Lanka	15.3	25.2	4.2	5.3
Sierra Leone	34.1	63.1	2.5	18.1
Philippines	18.3	42.3	1.7	8.3

Source: Based on data from World Bank (2001) and IMF (1999).

Table 1. (continued)

Variable/country	Mean	Maximum	Minimum	Std. Dev.
Consumer price index or P_i (1995=100)				
Malaysia	83.2	114.9	55.3	17.0
Chile	54.8	123.8	6.1	41.6
Thailand	80.0	121.1	43.0	22.4
Papua New Guinea	75.0	151.5	35.9	31.4
Bangladesh	72.1	125.9	26.0	29.9
Sri Lanka	65.0	145.4	15.3	41.3
Sierra Leone	51.2	257.2	0.1	73.3
Philippines	64.2	135.1	15.4	37.9
Inflation rate (fraction) *or* $\Delta lnP_i = \Delta p_i$				
Malaysia	0.037	0.093	0.003	0.021
Chile	0.157	0.301	0.033	0.078
Thailand	0.054	0.180	0.003	0.040
Papua New Guinea	0.071	0.159	0.028	0.037
Bangladesh	0.082	0.151	0.030	0.034
Sri Lanka	0.112	0.232	0.015	0.049
Sierra Leone	0.395	1.025	0.121	0.238
Philippines	0.111	0.383	-0.003	0.080
Deposit interest rate (fraction) or RS_i				
Malaysia	0.068	0.098	0.030	0.020
Chile	0.250	0.487	0.085	0.119
Thailand	0.106	0.137	0.047	0.022
Papua New Guinea	0.092	0.155	0.050	0.027
Bangladesh	0.100	0.121	0.060	0.023
Sri Lanka	0.156	0.198	0.085	0.030
Sierra Leone	0.173	0.547	0.070	0.137
Philippines	0.128	0.212	0.082	0.039
Lending interest rate (fraction) RL_i				
Malaysia	0.088	0.115	0.070	0.015
Chile	0.330	0.639	0.126	0.153
Thailand	0.137	0.172	0.090	0.023
Papua New Guinea	0.129	0.189	0.092	0.024
Bangladesh	0.139	0.160	0.110	0.017
Sri Lanka	0.136	0.190	0.060	0.034
Sierra Leone	0.282	0.628	0.110	0.151
Philippines	0.178	0.286	0.118	0.047

Source: Based on data from World Bank (2001) and IMF (1999).

Table 1. (continued)

Variable/country	Mean	Maximum	Minimum	Std. Dev.
Interest rate spread (fraction) RL_i-RS_i				
Malaysia	0.020	0.052	-0.012	0.014
Chile	0.081	0.169	0.037	0.038
Thailand	0.031	0.047	0.012	0.010
Papua New Guinea	0.037	0.069	0.008	0.018
Bangladesh	0.038	0.081	0.000	0.026
Sri Lanka	-0.020	0.095	-0.070	0.039
Sierra Leone	0.109	0.235	0.018	0.064
Philippines	0.051	0.097	0.016	0.017
Real GDP or Y_i **(1995=100)**				
Malaysia	67.9	118.1	33.1	29.0
Chile	70.9	119.2	41.2	27.6
Thailand	63.8	105.9	29.6	27.4
Papua New Guinea	77.4	107.7	58.3	18.9
Bangladesh	80.3	121.7	50.0	21.6
Sri Lanka	78.6	120.6	48.2	22.0
Sierra Leone	107.8	129.1	78.9	12.1
Philippines	88.4	114.0	71.3	13.4
Real GDP growth % or $\Delta lnY_i=\Delta y_i$				
Malaysia	6.3	9.5	-7.7	4.3
Chile	5.1	11.6	-10.9	5.2
Thailand	6.0	12.5	-10.7	5.0
Papua New Guinea	2.7	16.7	-4.0	5.6
Bangladesh	4.5	9.7	1.5	1.6
Sri Lanka	4.6	6.7	1.7	1.3
Sierra Leone	-1.3	5.8	-19.4	6.9
Philippines	2.3	6.5	-7.6	3.9
US long-term interest rate (fraction) or R_{US}				
R_{US}	0.060	0.087	0.035	0.014
Pooled data				
$M2_i/P_i$ (1995=100)	89.5	460.0	14.4	72.5
$\Delta(m_i/p_i)$ %	5.3	37.1	-53.1	10.8
$M2_i$ (1995=100)	58.3	292.5	0.3	53.8
$\Delta lnM2$ %	18.0	63.1	-3.3	11.5
P_i (1995=100)	68.2	257.2	0.1	40.8
$\Delta lnP_i= \Delta p_i$ fraction	0.127	1.025	-0.003	0.144
RS_i fraction	0.134	0.547	0.030	0.086
RL_i fraction	0.177	0.639	0.060	0.111
RL_i-RS_i fraction	-0.043	0.070	-0.235	0.049
Y_i (1995=100)	79.4	129.1	29.6	25.4
$\Delta lnY_i=\Delta y_i$ %	3.8	16.7	-19.4	5.1

Source: Based on data from World Bank (2001) and IMF (1999).

Table 2. Empirical results for the demand for M2, $(m_i/p_i)_t$, model pooling annual time series data (1980-1999) and eight developing countries

Variable	Coefficient	t-Statistic	Prob.
Common coefficients			
Δp_{it}	-0.631	-12.6	0.00
RL_{it}-RS_{it}	-0.303	-2.2	0.03
RL_{USt}	-0.582	-2.4	0.02
Cross-section specific coefficients			
$(m_i/p_i)_{t-1}$			
Malaysia	0.613	7.8	0.00
Chile	0.528	10.0	0.00
Thailand	0.643	11.7	0.00
Papua New Guinea	0.245	2.3	0.02
Bangladesh	0.746	8.3	0.00
Sri Lanka	0.465	3.9	0.00
Sierra Leone	0.927	16.8	0.00
Philippines	0.556	9.3	0.00
y_{it}			
Malaysia	0.567	5.0	0.00
Chile	0.410	6.3	0.00
Thailand	0.553	6.0	0.00
Papua New Guinea	0.629	7.5	0.00
Bangladesh	0.341	2.1	0.04
Sri Lanka	0.418	3.7	0.00
Sierra Leone	0.331	1.9	0.06
Philippines	1.433	7.6	0.00
Fixed Effects (intercept coefficients)			
Malaysia	-2.46	-4.7	0.00
Chile	-1.71	-5.7	0.00
Thailand	-2.38	-5.6	0.00
Papua New Guinea	-2.73	-7.2	0.00
Bangladesh	-1.45	-1.9	0.06
Sri Lanka	-1.88	-3.5	0.00
Sierra Leone	-1.24	-1.5	0.13
Philippines	-6.48	-7.3	0.00
$\bar{R}^2$=0.987			
DW=1.94			
Log likelihood=289			

Table 3. Testing for the significance of fixed effects (γ_{i0}) and country specific coefficients (γ_{i5} and γ_{i6})

The null hypothesis	Wald test	Probability
$H_0^1 : \gamma_{i0} = \gamma_0$	$F(7,133)=6.7$	0.000
	$\chi^2(7)=47.3$	0.000
$H_0^2 : \gamma_{i5} = \gamma_5$	$F(7,133)=6.8$	0.000
	$\chi^2(7)=47.5$	0.000
$H_0^3 : \gamma_{i6} = \gamma_6$	$F(7,133)=6.6$	0.000
	$\chi^2(7)=46.8$	0.000

Table 4. Testing for the autocorrelation of the country-specific residuals

H_0= no autocorrelation in e_{it}				
Country/lag	AC	PAC	Q-Stat	Probability
Malaysia				
1	-0.02	-0.02	0.01	0.94
2	-0.04	-0.04	0.04	0.98
Chile				
1	-0.28	-0.28	1.86	0.17
2	0.17	0.10	2.61	0.27
Thailand				
1	0.38	0.38	3.40	0.07
2	0.05	-0.12	3.47	0.18
Papua New Guinea				
1	0.31	0.31	2.16	0.14
2	-0.27	-0.40	3.95	0.14
Bangladesh				
1	0.08	0.08	0.16	0.69
2	-0.47	-0.48	5.60	0.07
Sri Lanka				
1	0.35	0.35	2.75	0.10
2	0.20	0.09	3.70	0.16
Sierra Leone				
1	-0.11	-0.11	0.27	0.61
2	0.05	0.04	0.32	0.85
Philippines				
1	0.22	0.22	1.08	0.30
2	-0.09	-0.14	1.28	0.53

Note: Based on the resulting residuals of the estimated equation (3) reported in Table 2.

Table 5. Testing for normality of the country-specific residuals

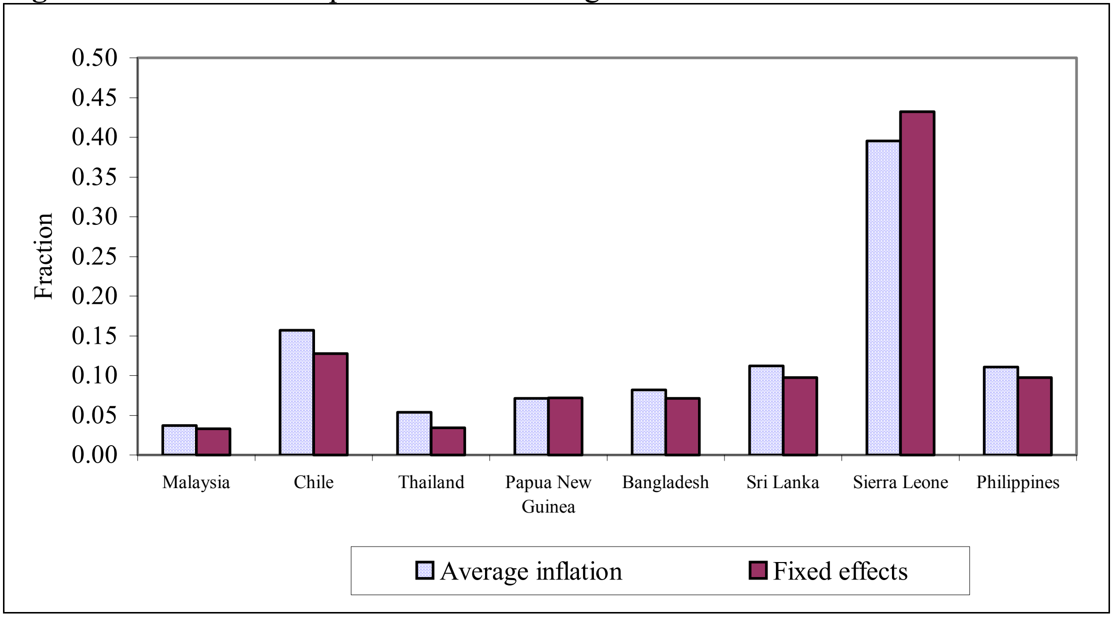
H_0= e_{it} are distributed normally		
Country	Jarque-Bera statistic	Probability
Malaysia	0.86	0.65
Chile	0.22	0.89
Thailand	0.61	0.74
Papua New Guinea	3.61	0.16
Bangladesh	0.74	0.69
Sri Lanka	0.39	0.82
Sierra Leone	1.15	0.56
Philippines	0.60	0.74

Table 6. The relationship between the estimated lagged disequilibrium in the money market (e_{it-1}) and the output gap and inflation

Independent variable	Dependent variable	
	Output gap or (y_{it}-y^p_{it})	Inflation Δp_{it}
$e_{it-1}=(m_i-p_i)_{t-1}$	**0.067** (4.6)*	**0.160** (5.6)*
Intercept	-0.002 (-1.0)	Fixed Effects
Malaysia	-	0.033 (5.1)*
Chile	-	0.128 (5.9)*
Thailand	-	0.034 (4.1)*
Papua New Guinea	-	0.072 (4.1)*
Bangladesh	-	0.071 (8.4)*
Sri Lanka	-	0.098 (5.6)*
Sierra Leone	-	0.432 (5.4)*
Philippines	-	0.098 (3.0)*
AR(1)	-0.33 (-4.7)*	0.46 (9.3)*
AR(2)	0.66 (9.1)*	-
$\bar{R}^2$	0.400	0.707
DW	1.79	2.20
Log likelihood	348.8	289.8

Notes: a) * indicates that the corresponding null hypothesis is rejected at 1% level;
b) The estimation method is SUR using annual time series data from 1980 to 1999 for eight developing countries.

Figure 1: The relationship between the average inflation rate and the fixed effects



Source: Average inflation figures are from Table 1 and the fixed effects (or country specific intercepts) are extracted from the inflation equation in Table 6.

References

Agenor, P.R. & Khan, M. (1992) Foreign currency deposits and the demand for money in developing countries, *International Monetary Fund Working Paper*: WP/92/1, January 1992.

Agenor, P.R. & Khan, M. (1996) Foreign currency deposits and the demand for money in developing countries, *Journal of Development Economics*, 50(1), pp. 101-18.

Arize, A. (1989) An econometric investigation of money demand behaviour in four Asian developing countries, *International Economic Journal*, 3(4), pp. 79-93.

Arize, A.C., Malindretos, J. & Shwiff, S.S. (1999) Structural breaks, cointegration, and speed of adjustment: evidence from 12 LDCs money demand, *International Review of Economics and Finance*, 8(4), pp. 399-420.

Arrau, P. (1991*)* The demand for money in developing countries: assessing the role of financial innovation, *International Monetary Fund Working Paper*: WP/91/45.

Bahmani-Oskooee, M. & Malixi, M. (1991) Exchange rate sensitivity of the demand for money in developing countries, *Applied Economics*, 23(8), pp. 1377-83.

Bahmani-Oskooee, M. and Rhee, H.J. (1994) Long-run elasticities of the demand for money in Korea: evidence from cointegration analysis*, International Economic Journal*, 8(2), pp. 83-93.

Ball, L. (2001) Another look at long-run money demand, *Journal of Monetary Economics*, 47, pp. 31-44.

Beck, N. and Katz, J.N. (1995) What to do (and not to do) with time-series cross-section data, *American Political Science Review*, 89(3), pp. 634-647.

Beyer, A. (1998) Modelling money demand in Germany, *Journal of Applied Econometrics*, 13, pp. 57-76.

Chowdhury, A.R. (1995) The demand for money in a small open economy: the case of Switzerland, *Open Economies Review*, 6(2), pp. 131-44.

Coenen, G. and Vega, J.L. (2001) The demand for M3 in the Euro area, *Journal of Applied Econometrics*, 16, pp. 727-48.

de Brouwer, G. (1998) Estimating output gaps, *Reserve Bank of Australia Research Discussion Paper* 9809 (Sydney, Reserve Bank of Australia).

de Brouwer, G., Ng, I., and Subbaraman, R. (1993) The demand for money in Australia: new tests on an old topic, *Research Discussion Paper*, No. 9314, (Sydney, Reserve Bank of Australia).

Ericsson, N.R. (1998) Empirical modeling of money demand, *Empirical Economics*, 23, pp. 295-315.

Ericsson, N.R. (1999) Empirical modelling of money demand, in: H. Lütkepohl & J. Wolters (Eds), *Money Demand in Europe* (Physica-Verlag, Heidelberg).

EViews (2002) *EViews 4 User's Guide*, (Irvine, Quantitative Micro Software).

Ewing, B.T, and Payne, J.E. (1999) Some recent international evidence on the demand for money, *Studies in Economics and Finance*, 19(2), pp. 84-107.

Felmingham, B. & Zhang, Q. (2001) The long run demand for broad money in Australia subject to regime shifts, *Australian Economic Papers*, 40, pp. 146-55.

Gerlach, S & Svensson, E.O. (2001) Money and inflation in the Euro are: a case for monetary indicators**?** *Bank for International Settlements Working Papers* No. 98, (Basel).

Goldfeld, S.M. (1994) Demand for money: empirical studies, in P. Newman, M. Milgrate & J. Eatwell (Eds) *The New Palgrave Dictionary of Money & Finance* (London, Macmillan Press).

Gupta, K.L.& Moazzami, B. (1989) Demand for money in Asia, *Economic Modelling*, 6(4), pp. 467-73.

Haltmaier, J. (2001), The use of cyclical indicators in estimating the output gap in Japan, *International Finance Discussion Paper* 701, Board of Governors of the Federal Reserve System.

Hayo, B. (1999) Estimating a European money demand function, *Scottish Journal of Political Economy*, 46, pp. 221-44.

Hodrick, R.J. & E.C. Prescott (1997) Postwar U.S. business cycles: an empirical investigation, *Journal of Money, Credit, and Banking*, 29, pp. 1–16.

Hoffman, D.L. & Rasche, RH. (2001) *Aggregate Money Demand Functions* (Boston, Kluwer Academic Publishers).

International Monetary Fund, IMF, (1999) *International Financial Statistics Yearbook 1999* (Washington DC).

Laidler, D. (1991) The quantity theory is always and everywhere controversial-why?, *Economic Record*, 67, pp. 289-306.

Laidler, D. (1993) *The Demand for Money: Theories, Evidence, and Problems*, (New York, Harper Colins College).

Laidler, D. (1999) The quantity of money and monetary policy, *Bank of Canada Working Paper Series* No. 99-5 (Bank of Canada).

McCallum, B.T (2001) Should monetary policy respond strongly to output gaps? *American Economic Review*, 91(2), pp.258-62.

Mundell, A. R. (1963), Capital mobility and stabilisation policy under fixed and flexible exchange rates, *Canadian Journal of Economics and Political Science*, 27, pp. 475-85.

Siklos, P.L. & Barton, A.G. (2001) Monetary aggregates as indicators of economic activity in Canada: empirical evidence, *Canadian Journal of Economics*, 34, pp. 1-17.

Simmons, R. (1992) An error-correction approach to demand for money in five African developing countries, *Journal of Economic Studies*, 19 (1), pp. 29-48.

Sriram, S.S. (2000), A survey of recent empirical money demand studies; *IMF Staff Papers*, 47(3), pp. 334-65.

Traa, B.M. (1991) Money demand in the Netherlands, *International Monetary Fund Working Paper, No. WP/91/57*, (Washington DC., IMF).

Wong, C.H. (1977) Demand for money in developing countries: some theoretical and empirical results, *Journal of Monetary Economics*, 3(1), pp. 59-86.

Woodford, M. (2001) The Taylor rule and optimal monetary policy, *American Economic Review*, 91(2), pp.232-237.

World Bank, (2001) *The 2001 World Development Indicators CD-ROM*, (Washington DC, The International Bank for Reconstruction and Development).

Notes

[1] For a concise review of the recent empirical money demand studies in the context of developing countries see Sriram (2000).

[2] For a detailed discussion of controversy about the quantity theory see Laidler (1991). See also, *inter alia*, Laidler (1993) and Hoffman and Rasche (2001) for a comprehensive account of the literature on money demand.

[3] For a critical review of potential shortcomings associated with SUR/Parks estimation method see Beck and Katz (1995).